DESCRIPTION

METHODS OF TREATING CUTANEOUS FLUSHING

Field of the Invention

The present invention relates to a method of treating, reducing, inhibiting, preventing and/or reversing cutaneous facial flushing caused by abnormal, endogenously-induced vasomotor instability associated with, but not limited to acne rosacea, menopause-associated hot flashes, hot flashes resulting from orchiectomy or ingestion of substances capable of inducing a cutaneous facial flushing reaction (e.g.: alcohol, chocolate, spices) by topical dermatological application of an effective dose of a composition comprising at least one α_2 adrenergic receptor agonist (such as a (2-imidazolin-2-ylamino) quinoxaline derivative such as brimonidine tartrate) and a suitable carrier.

Background of the Invention

Facial flushing is a symptom observed in medical conditions associated with vasomotor instability. Cutaneous vasomotor instability is the term commonly used in the medical arts to refer to involuntary dilatation and reactivity of subcutaneous blood vessels. The mechanism of facial flushing involves involuntary dilation of subcutaneous arteries. The etiology underlying the initiation of facial flushing is unknown. There are essentially four common medical conditions addressed by the instant disclosure in which facial flushing occurs. These include: 1.) acne rosacea, 2.) postmenopausal hot flashes, 3.) patients who are status post surgical orchiectomy, and 4.) flushing secondary to ingestion of food substances.

Acne rosacea is a chronic dermatological disease of unknown cause characterized by facial flushing, erythema, recurrent papules and pustules, superficial telangiectasias (dilations of previously existing small blood vessels) and rhinophymia (hypertrophy of the nose with follicular dilation). The disorder is found mainly in fair-skinned patients between 30 and 50 years of age. Women are more commonly affected than men and acne rosacea is a common disorder. Because these clinical signs, rosacea was originally thought to resemble the acne (acne vulgaris) typically encountered in teenagers, however, rosacea is now known to represent a

separate and distinct dermatological condition. It is estimated that approximately 13 million Americans have acne rosacea. Alcohol, stress, spicy foods and temperature extremes may exacerbate the condition.

Facial flushing associated with rosacea is due to vasomotor instability of unknown etiology. Therefore, treatments that stabilize the contractile state of cutaneous blood vessels would have a beneficial effect on this symptom. Improvement and stabilization of vascular tone via a vasoconstrictive mechanism is the approach taken by the instant disclosure. It appears that there are only two prior art patent methods of influencing vascular tone and reducing facial flushing. These include topical application of phytosphingosine (U.S. Published Application No. 2003/0068343) and nitric oxide synthetase inhibitors (WO 98/36730). Mechanistically, these differ greatly from the instant disclosure. Sphingosines are lipids that induce vasoconstriction in certain tissues via activity of specific cellular sphingosine receptors. Nitric oxide is a potent regulatory vasodilator that is produced by vascular endothelial cells. Inhibition of the enzyme that produces nitric oxide would therefore be expected to result in baseline vasoconstriction. However, the safety and tolerability of these compounds have not been established. Attempted treatment methods for facial flushing that have been published in the peer-reviewed medical literature have been limited to oral administration of the antihypertensive medication, clonidine (Guarrera *et al.*, 1982; Wilkin, 1983).

Clonidine is an alpha (α) adrenergic receptor agonist that crosses the blood-brain barrier and acts directly on the central nervous system. The chemical name of clonidine is N-(2,6-dichlorophenyl)-4,5-dihydro-1H-imidazol-2-amine. Clonidine has affinity for both the α_1 and α_2 subtypes of alpha adrenergic receptors. Traditionally, clonidine has been used to treat uncontrolled hypertension. Clonidine stimulates alpha adrenergic receptors in the brainstem, resulting in reduced sympathetic outflow that decreases renal vascular resistance, heart rate and blood pressure. Because clonidine acts directly on the central nervous system, its use is associated with multiple systemic side effects, such as bradycardia, heart block, hypotension, dizziness, dry mouth and depression. Some of the side effects may be life threatening.

For the purpose of patient convenience and desire to maintain adequate blood levels of the drug to control hypertension, clonidine has been administered via transdermal patch (U.S. Patent No. 4,201,211). However, this transdermal delivery system for clonidine is simply an

alternate route of administration and does not alter its ability to affect the central nervous system or its mixed α_1 and α_2 adrenergic receptor kinetics. Topical clonidine has also been proposed to aid in alleviating neuropathic pain syndromes such as diabetic neuropathy and post-herpetic neuralgia (U.S. Patent No. 6,534,048). However, the mechanism of this analgesic action may be secondary to the release of endogenous enkephalin-like substances by the central nervous system (Nakamura *et al.*, 1988).

Research has shown that vasoconstriction of small, distal subcutaneous resistance arteries depends entirely on α_2 adrenergic receptor stimulation (Chotani *et al.*, 2000; Nielson *et al.*, 1989). Unfortunately, because of its mixed α_1 and α_2 activity, oral dosages of clonidine sufficient to produce peripheral cutaneous vasoconstriction via α_2 adrenergic receptor stimulation would also result in intolerable systemic side effects. Hot flashes are sudden sensations of flushing and heat that some women experience when they are going through menopause. Although their etiology is not completely understood, it is thought that a decrease in the female hormone estrogen leads to vasomotor instability. Symptoms include redness and warmth of the skin of the face, neck and shoulders, pounding heartbeat and sweating. Hot flashes last from a few minutes to a half hour. Approximately 20% of women seek medical treatment for postmenopausal symptoms associated with vasomotor instability. Similar symptoms are experienced by men with prostate cancer who undergo orchiectomy (surgical removal of the testes). Treatment of hot flashes requires oral estrogen replacement therapy which is thought to raise the core body temperature sweating threshold (Freedman *et al.*, 2002). However, many patients have relative or absolute contraindications to estrogen replacement therapy (eg: history of breast cancer). These patients would benefit from a safe, locally-acting compound that alleviates facial flushing. Although the exact etiology of hot flashes is unknown, the underlying physiological mechanism of facial flushing (dilation of subcutaneous arteries) is similar to that observed with rosacea in that there is endogenously-induced vasomotor instability. Treatment of the reactive cutaneous vascular bed with the (2-imidazolin-2-ylamino) quinoxaline derivative brimonidine tartrate would stimulate α_2 adrenergic receptors, thus restoring vascular tone and reversing or preventing the cutaneous flushing reaction.

It is known that patients with vasomotor instability are also susceptible to facial flushing following the ingestion of certain foods such as alcohol, chocolate, caffeine or spices. Flushing

associated with ingested substances is primarily limited to the "blush area" of the mid face (Wilkin, 1988).

Topical brimonidine tartrate eye drops have been FDA approved for the treatment of elevated intraocular pressure. In addition to treating elevated intraocular pressure, brimonidine tartrate eye drops have also been patented for treating neural injury secondary to glaucoma, retinitis pigmentosa and age related macular degeneration (U.S. Patent No. 6,194,415). Brimonidine tatrate is known to have 10 fold more α_2 adrenergic receptor activity than clonidine (Burke *et al.*, 1996) and because of its hydrophilic composition, is capable of acting locally and is unable to cross the blood-brain barrier and therefore, unable to directly influence the central nervous system (Chien *et al.*, 1990). Toxicity studies have proven brimonidine tartrate to be nontoxic and to have no oncogenic or teratogenic activity (Walters, 1996).

Brief Summary of the Invention

The instant invention involves topical cutaneous application of at least one α_2 adrenergic receptor agonist, such as the (2-imidazolin-2-ylamino) quinoxaline derivative brimonidine tartrate, which is a highly effective treatment for cutaneous facial flushing caused by vasomotor instability.

One objective of the present invention involves local cutaneous application of an effective amount of at least one α_2 adrenergic receptor agonist with an ability to act locally and inability to cross the blood-brain barrier to treat facial flushing reactions caused by vasomotor instability. In certain preferred embodiments, the α_2 adrenergic receptor agonist is bromonidine tartrate.

Thus, the instant disclosure describes a method of safely treating facial flushing in humans. This method comprises administering a composition comprising an effective amount of at least one α_2 adrenergic receptor agonist, for example, brimonidine tartrate, wherein the α_2 adrenergic receptor agonist is admixed with a dermatologically acceptable carrier or a pharmaceutically acceptable carrier. This compound, due to its properties as a highly specific, locally-acting α_2 adrenergic receptor agonist, acts to reduce cutaneous flushing via vasoconstriction of subcutaneous arteries.

Detailed Disclosure of the Invention

The subject invention provides methods for the treatment of flushing in an individual comprising the administration of a composition comprising at least one selective α_2 adrenergic receptor agonist and a carrier in an amount sufficient to prevent, reduce, ameliorate, or inhibit facial flushing. In a preferred embodiments, brimonidine tartrate is an α_2 adrenergic receptor agonist used in the formulation of the compositions used in the subject invention. In various aspects of the subject invention, the individual is a human. In other embodiments, the subject invention treats facial flushing in individuals or humans.

Selective α_2 adrenergic receptor agonists suitable for use in the subject invention include, and are not limited to, guanabenz, guanfacine, alpha-methyl DOPA (methydopamine), amphetamine, methylphenidate, lofexidine, moxonidine, dexmedetomidine, mivazerol, (2-imidazolin-2-ylamino) quinoxaline derivatives (including, but not limited to, brimonidine tartrate). Brimonidine tartrate is a quinoxaline derivative and quinoxaline derivatives having α_2 receptor agonist activity were originally suggested as therapeutic agents by U.S. Patent No. 4,029,792 which is hereby incorporated by reference in its entirety.

The phrase "selective α_2 adrenergic receptor agonist(s)" is intended to convey an agonist (or agonists) that are more selective for the α_2 adrenergic receptor as compared to the α_1 adrenergic receptor. In certain embodiments of the invention, "selective α_2 adrenergic receptor agonist(s)" are at least ten (10) to 1000-fold (or higher) more selective for the α_2 adrenergic receptor than the α_1 adrenergic receptor. Other embodiments provide for "selective α_2 adrenergic receptor agonist(s)" that are at least two-fold to 50-fold (or higher) more selective for the α_2 adrenergic receptor as compared to clonidine (for example, brimonidine is 7-12 fold more selective for the α_2 adrenergic receptor than is clonidine).

For the treatment of facial flushing in humans, one embodiment of the subject invention provides a (2-imidazolin-2-ylamino) quinoxaline derivative, such as brimonidine tartrate admixed with a dermatologically acceptable carrier which is then administered topically in accordance with the present invention to skin. Any suitable, conventional, dermatologically acceptable carrier may be employed. A carrier is dermatologically acceptable if it does not inhibit the effectiveness of the active compound(s) and it has substantially no long term or

permanent detrimental effect on the skin to which it is administered. In various preferred embodiments, compositions of the subject invention are topically administered to facial skin.

The compositions encompassed by this invention include formulations for topical application to the human skin. For topical application, one or more α_2 adrenergic receptor agonists, such as (2-imidazolin-2-ylamino) quinoxaline derivatives (a non-limiting example of which is brimonidine tartrate), may be formulated into any pharmaceutical form normally employed for such an application, in particular in the form of aqueous, aqueous/alcoholic or oily solutions, dispersions of lotion or serum type, aqueous anhydrous or lipophilic gels, emulsions of liquid or semi-liquid consistency of the milk type, obtained by dispersion of a fatty phase in an aqueous phase or conversely an aqueous phase in a fatty phase, or suspensions or emulsions of semi-solid or solid consistency of the cream or gel type, soaps or detergents, or alternatively microemulsions, microcapsules, microparticles, or vesicle dispersions of ionic and/or non-ionic type. Among additional alternative means for topical application of compositions according to the subject invention are spray pumps, aerosol dispersions, impregnated cosmetic facial masks, and impregnated cosmetic facial cloths or sponges. These formulations may be produced by conventional techniques.

Preparation of the compositions comprising one or more α_2 adrenergic receptor agonists, such as the (2-imidazolin-2-ylamino) quinoxaline derivative brimonidine tartrate, admixed with dermatologically accepted carriers would also include standard acids, bases and buffers including, but not limited to substances such as sodium hydroxide and lactic acid to adjust and optimize pH between approximately 6.0 and 8.5.

Compositions of the subject invention can also further comprise standard dermatological preservatives to prevent the growth of microorganisms. Such standard preservatives include substances such as benzoic acid, benzyl alcohol, phenoxyethanol and parabens. Appropriate binding agents or other substances may be included to alter the viscosity or color of the final preparation.

Compositions provided by the subject invention can also contain, in addition to the components discussed *supra*, compounds known to be beneficial to the treatment of acne rosacea in addition to one or more α_2 adrenergic receptor agonists, such as the (2-imidazolin-2-ylamino) quinoxaline derivative brimonidine tartrate. These additional compounds include, and are not limited to,

antibacterial agents, anthelmintic agents, antiangiogenesis agents, steroidal anti-inflammatory agents, non-steroidal anti-inflammatory agents, antioxidants or derivatives of retinoic acid, as well as halogens. Compositions according to the subject invention can also further comprise aloe for skin protection and/or a compound known to act as a sunscreen in addition to those components discussed herein. As would be apparent to the skilled artisan, compositions used in the practice of the subject invention, can have any combination of the components discussed herein.

While the present invention has been described in terms of various preferred embodiments, those of ordinary skill in the art will appreciate that various modifications, substitutions, omissions, and changes may be made without departed from the spirit of the invention. Accordingly, it is intended that the scope of the present invention not be limited solely by the instant disclosure and the scope of the following claims, including equivalents thereof.

References

U.S. Patent No. 4,029,792

U.S. Patent No. 6,194,415

U.S. Published Application No. 2003/0068343

U.S. Patent No. 4,201,211

U.S. Patent No. 6,534,048

WO98/36730

Guarrera, M. *et al.* (1982) "Flushing in rosacea: a possible mechanism" *Archives of Dermatological Research* 272(3-4):311-16.

Wilkin, J.K. (1983) "Effect of subdepressor clonidine on flushing reactions in rosacea. Change in malar thermal circulation index during prolonged flushing reactions" *Archives of Dermatology* 119(3):211-14.

Chotani, M.A. *et al.* (2000) "Silent alpha (2C)-adrenergic receptors enable cold-induced vasoconstriction in cutaneous arteries" *American Journal of Physiology Heart Circulatory Physiology* 278(4):H1075-83.

Nielson, H. *et al.* (1989) "Postjunctional alpha 2-adrenergic receptors mediate vasoconstriction in human subcutaneous resistance vessels" *British Journal of Pharmacology* 97(3):829-34.

Burke, J. *et al.* (1996) "Preclinical evaluation of brimonidine tartrate" *Survey of Ophthalmology* 41(suppl):S9-S18.

Walters, T.R. (1996) "Development and use of brimonidine in treating acute and chronic elevations of intraocular pressure: A review of safety, efficacy, dose response, and dosing studies" *Survey of Ophthalmology* 41(suppl):S19-S26.

Chien, D.S. *et al.* (1990) "Corneal and conjunctival/scleral penetration of *p*-aminoclonidine, AGN 190342 and clonidine in rabbit eyes" *Current Eye Research* 9:1051-59.

Freedman, R.R. *et al.* (2002) "Estrogen raises the sweating threshold in postmenopausal women with hot flashes" *Fertility and Sterility* 77(3):487-90.

Wilkin, J.K. (1988) "Why is flushing limited to a mostly facial cutaneous distribution?" *Journal of the American Academy of Dermatology* 19:309-13.

Nakamura, M. *et al.* (1988) "Peripheral analgesic action of clonidine: mediation by release of endogenous enkephalin-like substances" *European Journal of Pharmacology* 146:223-28.